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(54) Dry cleaning composition and process

(57) A dry cleaning composition containing a cyclic siloxane and a siloxane surfactant and, optionally, water, as well as a method for dry cleaning comprising contacting an article with the composition are disclosed. The method removes both water and oil soluble stains from the article.

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## Description

[0001] The present invention is directed to a composition, more specifically, to a siloxane fluid based composition, for use in dry cleaning and to a dry cleaning process using the composition.

[0002] Current dry cleaning technology uses perchloroethylene ("PERC") or petroleum-based materials as the cleaning solvent. PERC suffers from toxicity and odor issues. The petroleum-based products are not as effective as PERC in cleaning garments.

[0003] Cyclic siloxanes have been reported as spot cleaning solutions, see US 4,685,930. Other patents disclose the use of silicone soaps in petroleum solvents, see JP 09299687, and the use of silicone surfactants in super critical carbon dioxide solutions has been reported, see, for example, US 5,676,705 and Chem. Mark. Rep., 15 Dec 1997, 252(24), p. 15. Non-volatile silicone oils have also been used as the cleaning solvent requiring removal by a second washing with perfluoroalkane to remove the silicone oil, see JP 06327888.

[0004] Numerous other patents have issued in which siloxanes or organomodified silicones have been present as addenda in PERC or petroleum based dry cleaning solvents, see, for example, WO 9401510; US 4911853; US 4005231; US 4065258.

[0005] In a first aspect, the present invention is directed to a dry cleaning composition, comprising a cyclic siloxane and a siloxane surfactant.

[0006] In a second aspect, the present invention is directed to a method for dry cleaning an article, comprising contacting the article with a composition comprising a cyclic siloxane and a siloxane surfactant.

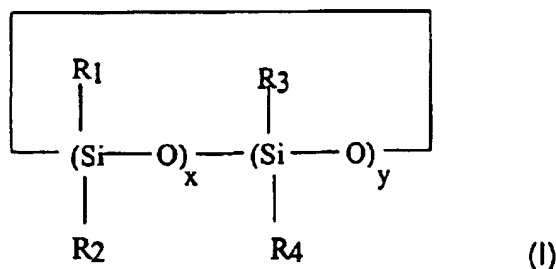
[0007] The process of the present invention effectively removes both oil soluble and water soluble stains from the article, for example a garment, being cleaned and suppresses redeposition of soil on the article.

[0008] In a preferred embodiment, the composition comprises, based on 100 parts by weight ("pbw") of the composition, from 80 pbw to 99.99 pbw, more preferably from 90 pbw to 99.9 pbw and even more preferably from 92 pbw to 99.5 pbw of the cyclic siloxane and from 0.01 pbw to 20 pbw, more preferably from 0.1 pbw to less than 10 pbw and even more preferably from 0.5 pbw to 8 pbw of the siloxane surfactant.

[0009] In a preferred embodiment, the composition further comprises, based on 100 pbw of the composition, up to 10 pbw, more preferably from 0.01 pbw to 10 pbw, even more preferably from 0.1 pbw to 5 pbw, even more preferably 0.5 pbw to 2 pbw water.

[0010] Compounds suitable as the cyclic siloxane component of the present invention are those containing a polysiloxane ring structure that includes from 2 to 20 silicon atoms in the ring. Preferably, the cyclic siloxanes are relatively volatile materials, having, for example, a boiling point of below about 250°C at a pressure of 760 millimeters of mercury ("mm Hg").

[0011] In a preferred embodiment, the cyclic siloxane comprises one or more compounds of the structural formula (I):



wherein:

R<sup>1</sup>, R<sup>2</sup>, R<sup>3</sup>, R<sup>4</sup> are each independently a monovalent hydrocarbon group; and x and y are each independently integers from 0 to 10, provided that 3 ≤ (x + y) ≤ 10.

[0012] Preferred monovalent hydrocarbon groups are monovalent alkyl groups, monovalent aryl groups and monovalent aralkyl groups, more preferably, the monovalent hydrocarbon group is a monovalent (C<sub>1</sub>-C<sub>6</sub>)alkyl group, most preferably, methyl.

[0013] As used herein, the term "(C<sub>1</sub>-C<sub>6</sub>)alkyl" means a linear or branched alkyl group, containing from 1 to 6 carbons per group, such as, for example, methyl, ethyl, propyl, iso-propyl, n-butyl, iso-butyl, sec-butyl, tert-butyl, pentyl, hexyl, preferably methyl.

[0014] As used herein, the term "aryl" means a monovalent unsaturated hydrocarbon ring system containing one or more aromatic rings per group, which may optionally be substituted on the one or more aromatic rings, preferably with one or more (C<sub>1</sub>-C<sub>6</sub>)alkyl groups and which, in the case of two or more rings, may be fused rings, including, for example, phenyl, 2,4,6-trimethylphenyl, 2-isopropylmethylphenyl, 1-pentalenyl, naphthyl, anthryl, preferably phenyl.

5 [0015] As used herein, the term "aralkyl" means an aryl derivative of an alkyl group, preferably a (C<sub>2</sub>-C<sub>6</sub>)alkyl group, wherein the alkyl portion of the aryl derivative may, optionally, be interrupted by an oxygen atom, such as, for example, phenylethyl, phenylpropyl, 2-(1-naphthyl)ethyl, preferably phenylpropyl, phenoxypropyl, biphenyloxypropyl.

[0016] In a preferred embodiment, the cyclic siloxane comprises one or more of, octamethylcyclotetrasiloxane, decamethylcyclopentasiloxane, dodecamethylcyclohexasiloxane, tetradecamethylcycloheptasiloxane. In a more highly  
10 preferred embodiment, the cyclic siloxane of the present invention comprises decamethylcyclopentasiloxane. In a highly preferred embodiment, the cyclic siloxane component of the composition of the present invention consists essentially of decamethylcyclopentasiloxane.

[0017] Suitable cyclic siloxanes are made by known methods, such as, for example, hydrolysis and condensation of dimethyldichlorosilane and are commercially available.

15 [0018] In a preferred embodiment, the siloxane surfactant component of the present invention comprises one or more polyether siloxane compounds according to the structural formula II:



20 wherein:

M is R<sup>5</sup><sub>3</sub>SiO<sub>1/2</sub>;

D is R<sup>6</sup><sub>2</sub>SiO<sub>2/2</sub>;

25

M\* is R<sup>7</sup><sub>3</sub>SiO<sub>1/2</sub>;

D\* is R<sup>8</sup><sub>2</sub>SiO<sub>2/2</sub>;

30

each R<sup>5</sup>, R<sup>6</sup> is independently H, or a monovalent hydrocarbon group,

each R<sup>7</sup> is independently H, a monovalent hydrocarbon group, or (CH<sub>2</sub>)<sub>g</sub>-O-(C<sub>2</sub>H<sub>4</sub>O)<sub>h</sub>-(C<sub>3</sub>H<sub>6</sub>O)<sub>i</sub>-(C<sub>n</sub>O<sub>2n</sub>O)<sub>j</sub>-R<sup>11</sup>,  
provided that at least one R<sup>7</sup> is (CH<sub>2</sub>)<sub>g</sub>-O-(C<sub>2</sub>H<sub>4</sub>O)<sub>h</sub>-(C<sub>3</sub>H<sub>6</sub>O)<sub>i</sub>-(C<sub>n</sub>O<sub>2n</sub>O)<sub>j</sub>-R<sup>11</sup>;

35

each R<sup>8</sup> is independently H, a monovalent hydrocarbon group, or (CH<sub>2</sub>)<sub>g</sub>-O-(C<sub>2</sub>H<sub>4</sub>O)<sub>h</sub>-(C<sub>3</sub>H<sub>6</sub>O)<sub>i</sub>-(C<sub>n</sub>O<sub>2n</sub>O)<sub>j</sub>-R<sup>11</sup>,  
provided that at least one R<sup>8</sup> is (CH<sub>2</sub>)<sub>g</sub>-O-(C<sub>2</sub>H<sub>4</sub>O)<sub>h</sub>-(C<sub>3</sub>H<sub>6</sub>O)<sub>i</sub>-(C<sub>n</sub>O<sub>2n</sub>O)<sub>j</sub>-R<sup>11</sup>;

R<sup>11</sup> is H, a monovalent hydrocarbon group or alkyloxy;

40

0 ≤ a ≤ 2;

0 ≤ e ≤ 1000;

0.1 ≤ f ≤ 50;

45

1 ≤ g ≤ 16;

0 ≤ h ≤ 30;

50

0 ≤ i ≤ 30;

0 ≤ j ≤ 30; and

4 ≤ n ≤ 8

55

provided that h + i + j > 0.

[0019] In a preferred embodiment, 2 ≤ h ≤ 25, 0 ≤ i ≤ 25 and 0 ≤ j ≤ 25, more preferably j is 0.

Rating	5 = complete removal of stain
	4 = slight stain remaining
	3 = moderate stain removal
	2 = slight stain removal
	1 = no stain removal

[0027] The amounts of D<sub>5</sub>, polyether siloxane and water used in each of Examples 1-56 and Comparative Examples C1-C4, the type of stain and the results obtained are set forth in TABLES I-IV below.

TABLE I

Exp #	D <sub>5</sub> , Amount (g)	Stain	Polyether Siloxane	Polyether Siloxane, Amount (g)	H <sub>2</sub> O, Amount (g)	Cleaning
C1	49.5	Salt	--	--	--	2.3
1	49.5	Salt	A	0.5	--	3.7
2	49	Salt	A	0.5	0.5	4.7
3	49.5	Salt	F	0.5	--	3.7
4	49	Salt	F	0.5	0.5	3.7
5	49.5	Salt	B	0.5	--	4
6	49	Salt	B	0.5	0.5	4
7	49.5	Salt	C	0.5	--	4.7
8	49	Salt	C	0.5	0.5	4
9	49.5	Salt	D	0.5	--	4
10	49	Salt	D	0.5	0.5	2.7
11	49.5	Salt	E	0.5	--	4.7
12	49	Salt	E	0.5	0.5	4.3
13	49.5	Salt	B/E	0.25/0.25	--	2.7
14	49	Salt	B/E	0.25/0.25	0.5	4

TABLE II

Exp #	D <sub>5</sub> , Amount (g)	Stain	Polyether Siloxane	Polyether Siloxane, Amount (g)	H <sub>2</sub> O, Amount (g)	Cleaning
C2	47.5	Salt	--	--	--	2.7
15	47.5	Salt	A	2.5	--	5
16	47	Salt	A	2.5	0.5	5
17	47.5	Salt	F	2.5	--	3
18	47	Salt	F	2.5	0.5	4.3
19	47.5	Salt	B	2.5	--	5

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TABLE II (continued)

Exp #	D <sub>5</sub> , Amount (g)	Stain	Polyether Siloxane	Polyether Siloxane, Amount (g)	H <sub>2</sub> O, Amount (g)	Cleaning
20	47	Salt	B	2.5	0.5	5
21	47.5	Salt	C	2.5	--	4
22	47	Salt	C	2.5	0.5	4.7
23	47.5	Salt	D	2.5	--	5
24	47	Salt	D	2.5	0.5	5
25	47.5	Salt	E	2.5	--	4.7
26	47	Salt	E	2.5	0.5	4.7
27	47.5	Salt	B/E	1.25/1.25	--	3
28	47	Salt	B/E	1.25/1.25	0.5	3.7

TABLE III

Exp #	D <sub>5</sub> , Amount (g)	Stain	Polyether Siloxane	Polyether Siloxane, Amount (g)	H <sub>2</sub> O, Amount (g)	Cleaning
C3	49.5	Oil	--	--	--	4
29	49.5	Oil	A	0.5	--	5
30	49	Oil	A	0.5	0.5	4
31	49.5	Oil	F	0.5	--	5
32	49	Oil	F	0.5	0.5	5
33	49.5	Oil	B	0.5	--	4.7
34	49	Oil	B	0.5	0.5	3.7
35	49.5	Oil	C	0.5	--	4
36	49	Oil	C	0.5	0.5	3
37	49.5	Oil	D	0.5	--	3.7
38	49	Oil	D	0.5	0.5	5
39	49.5	Oil	E	0.5	--	5
40	49	Oil	E	0.5	0.5	5
41	49.5	Oil	B/E	0.25/0.25	--	4.7
42	49	Oil	B/E	0.25/0.25	0.5	5

TABLE IV

Exp #	D <sub>5</sub> , Amount (g)	Stain	Polyether Siloxane	Polyether Siloxane, Amount (g)	H <sub>2</sub> O, Amount (g)	Cleaning
C4	47.5	Oil	--	--	--	4
43	47.5	Oil	A	2.5	--	5

TABLE IV (continued)

Exp #	D <sub>5</sub> , Amount (g)	Stain	Polyether Siloxane	Polyether Siloxane, Amount (g)	H <sub>2</sub> O, Amount (g)	Cleaning
44	47	Oil	A	2.5	0.5	5
45	47.5	Oil	F	2.5	--	5
46	47	Oil	F	2.5	0.5	5
47	47.5	Oil	B	2.5	--	5
48	47	Oil	B	2.5	0.5	5
49	47.5	Oil	C	2.5	--	5
50	47	Oil	C	2.5	0.5	4
51	47.5	Oil	D	2.5	--	5
52	47	Oil	D	2.5	0.5	5
53	47.5	Oil	E	2.5	--	5
54	47	Oil	E	2.5	0.5	5
55	47.5	Oil	B/E	1.25/1.25	--	5
56	47	Oil	B/E	1.25/1.25	0.5	4.5

# Claims

1. A dry cleaning composition, comprising a cyclic siloxane and a siloxane surfactant.
2. A method for dry cleaning an article, comprising contacting the article with a composition comprising a cyclic siloxane and a siloxane surfactant.



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# EUROPEAN SEARCH REPORT

Application Number  
EP 00 30 1475

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (InCL7)
E	US 6 063 135 A (BERNDT DIETER R ET AL) 16 May 2000 (2000-05-16) * claims 1,2 *	1,2	D06L1/04
A	DE 37 39 711 A (KREUSSLER CHEM FAB) 8 June 1989 (1989-06-08) * abstract *	1,2	
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The present search report has been drawn up for all claims			TECHNICAL FIELDS SEARCHED (InCL7)
			D06L
Place of search		Date of completion of the search	Examiner
THE HAGUE		18 July 2000	Saunders, T
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